

Chapter 4

Clean cookstove adoption as a pathway to enhancing mental well-being among widowed women in Nigeria

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1.0 Introduction

Widows in Nigeria face a multitude of challenges, including financial instability, social marginalization, and limited access to essential services (Ajala, 2023; Ehumadu, 2022; Eteng, 2022). Among these issues, the reliance on traditional cooking methods using solid fuels like firewood and charcoal stands out as a critical concern, posing significant health risks and contributing to environmental degradation. This discussion explores the potential of clean cookstoves as a transformative solution to enhance the mental health and overall well-being of widowed women in Nigeria (Njenga et al., 2019; Onaivi et al., 2022; Pérez et al., 2022). The death of a spouse often leaves widowed women in Nigeria in vulnerable situations (Ajayi et al., 2019; Nwokoro & Ogba, 2019; Ugwu et al., 2020). Many experience financial hardship due to restricted access to income-generating opportunities compared to their married counterparts. Social exclusion further compounds their struggles, as widows frequently face stigma and are pushed to the fringes of their communities. Additionally, the lack of access to modern amenities, such as clean cooking technologies, worsens their circumstances and negatively impacts their quality of life. Clean cookstoves present a promising alternative to traditional cooking practices, addressing both health and environmental concerns (Aemro, Moura, & de Almeida, 2021; Wright, Sathre, & Buluswar, 2020). These stoves utilize cleaner energy sources, such as liquefied petroleum gas (LPG) or biofuels, which significantly reduce indoor air pollution and lower the risk of respiratory illnesses. Moreover, clean cookstoves are more fuel-efficient and produce fewer emissions, making them an environmentally sustainable option. Their adoption can play a crucial role in improving the mental and physical health of widowed women in Nigeria (Bassey et al., 2023; Garrison, 2021; Nnagbo, 2023; Sani & Scholz, 2022). By providing widows with access to these technologies, their health can be improved, their environmental impact minimized, and their ability to lead healthier,

more sustainable lives enhanced. This paper examines the benefits of clean cookstove adoption for widowed women in Nigeria and proposes strategies to promote their widespread use. In Nigeria, cooking is deeply embedded in cultural traditions and societal expectations, with women, including widows, typically responsible for this task. This cultural norm, coupled with limited access to resources, often places widowed women in challenging situations, particularly concerning their health and the well-being of their families (God'spresence, 2021; Timothy Adidi & Uche, 2022).

Traditional cooking methods, such as open fires or rudimentary stoves fueled by biomass, pose significant health risks due to indoor air pollution (Ali et al., 2021; Gangiah, 2022; Mutua, 2022). According to the World Health Organization (WHO), smoke from these methods is responsible for over 4 million premature deaths annually, with women and children being the most affected. The reliance on solid fuels like firewood and charcoal not only leads to respiratory diseases but also requires substantial time and physical effort for collection. This adds to the mental strain on widowed women, who may already be grappling with grief, isolation, and financial difficulties (Chakrabarti et al., 2023; Dakua, Karmakar, & Barman, 2022).

The adoption of clean cookstoves offers a viable solution to these challenges. By providing widowed women with access to efficient and cleaner cooking technologies, their health can be improved, their environmental impact reduced, and their overall quality of life enhanced. Clean cookstoves consume less fuel, emit less smoke, and cook food more efficiently, saving time and effort. This allows widowed women to dedicate more time to other productive activities or self-care. This paper investigates the potential of clean cookstove adoption as a means to improve the mental well-being of widowed women in Nigeria. It highlights the health, environmental, and socio-economic benefits of clean cookstoves, emphasizing their transformative impact on the lives of widowed women. Additionally, it addresses the challenges and barriers to adoption and proposes strategies to encourage the widespread acceptance and use of these technologies among widowed women in Nigeria. Widowed women in Nigeria often endure stigma, discrimination, and financial hardships, which can severely affect their mental health (Augustine Bala, Azman, & Singh, 2022; Dube, 2023; Ukeachusim et al., 2023). The loss of a spouse often leaves them financially vulnerable, as they may lack the resources or support systems needed to sustain themselves and their families. Many widowed women are forced to rely on traditional cooking methods, such as open fires or basic stoves, which exacerbate their health issues and add to their daily burdens (Date-Bah, 2022; Evans et al., 2020; Jadhav, 2018). Clean cookstove adoption offers a comprehensive approach to addressing the challenges faced by widowed women in Nigeria (Odo et al., 2021; Okereke et al., 2023; Onah, Nyong, & Ayuba, 2021). By providing access to efficient and clean

cooking technologies, their health can be improved, and they can gain greater control over their lives. Clean cookstoves reduce the time and effort required for cooking, enabling widowed women to pursue education, engage in income-generating activities, or spend more time with their families. Furthermore, clean cookstoves contribute to environmental preservation by reducing deforestation and greenhouse gas emissions (Karanja & Gasparatos, 2019; Manaye et al., 2022; Sundberg et al., 2020). This is particularly significant in Nigeria, where high deforestation rates contribute to environmental degradation and climate change. In summary, the adoption of clean cookstoves has the potential to significantly enhance the mental well-being of widowed women in Nigeria (Amoak, Najjar, & Kyle, 2022; Clancy et al., 2019; Ijoma, 2021). By addressing the health, environmental, and socio-economic challenges they face, clean cookstoves can empower widowed women to lead healthier, more sustainable lives, ultimately improving their mental health and overall quality of life.

2.0 Procedure for literature analysis; identification, screening and eligibility

To perform an in-depth literature review, leverage academic databases such as PubMed, Google Scholar, and ScienceDirect. Use search terms like "clean cookstove adoption," "mental health," "widowed women," and "Nigeria" to narrow down the results. Locate studies, articles, and reports that investigate the uptake of clean cookstoves by widowed women in Nigeria and its influence on their mental health (Gusenbauer & Haddaway, 2020; Houshyar & Sotudeh, 2018; Nugroho, Afifah, & Perdana, 2023; Shehu, 2018). Filter the retrieved literature for relevance, excluding works that do not focus on clean cookstove adoption among widowed women or lack a focus on mental health outcomes. Examine the abstracts and summaries of the literature to determine their relevance to the research question. Assess the suitability of the filtered literature using predefined inclusion and exclusion criteria. Inclusion criteria might include studies conducted in Nigeria, focusing on widowed women, and exploring the mental health effects of clean cookstove adoption (Daniyan, 2023; Owiyo, 2022; Yakubu, 2022). Exclusion criteria could involve studies not conducted in Nigeria, not focused on widowed women, or not specifically addressing mental health outcomes. Extract relevant data from the selected literature, including study details (e.g., author, publication year, study design), participant information (e.g., sample size, demographics), intervention specifics (e.g., type of clean cookstove, intervention duration), and mental health outcomes. Synthesize the findings to identify common themes, trends, and research gaps. Compare and contrast the results of different studies to draw conclusions about the impact of clean cookstove adoption on the mental health of widowed women in Nigeria (Barkema, Bindl, & Tanveer, 2023; Diener, Oishi, & Tay, 2018; Tetteh, 2018). Critically assess the quality of the included studies

using appropriate tools or frameworks, such as the CASP (Critical Appraisal Skills Programme) tool for qualitative studies or the JBI (Joanna Briggs Institute) Critical Appraisal Checklist for quantitative studies (Long, French, & Brooks, 2020; Ma et al., 2020; Walker et al., 2023). Consider the strengths and limitations of each study when interpreting the findings and formulating conclusions. Prepare a detailed report summarizing the literature analysis, outlining the methodology, key findings, implications for practice and policy, and recommendations for future research. By following this systematic approach, researchers can effectively analyze the literature on clean cookstove adoption among widowed women in Nigeria and its impact on their mental health, providing valuable insights for future research and program development.

3.0 Result

Research has shown that the use of clean cookstoves by widowed women in Nigeria has significantly decreased indoor air pollution, a key factor in respiratory diseases. This reduction in pollution can enhance mental health by alleviating the stress and physical discomfort linked to respiratory conditions. Additionally, the adoption of clean cookstoves has empowered these women by allowing them greater control over their cooking methods and environments (Dutta & Sahu, 2024; Otieno, 2019). Such empowerment boosts self-esteem and confidence, further contributing to improved mental health. Moreover, the shift to clean cookstoves has increased environmental consciousness among these women, instilling a sense of pride and satisfaction from engaging in eco-friendly cooking practices (Pazhoothundathil & Bailey, 2021; Roy, 2020; Soltani, 2021). This heightened awareness can foster a more optimistic life perspective and a feeling of purpose.

Community involvement initiatives, including educational workshops and awareness drives, are often part of clean cookstove programs. These efforts have strengthened community ties for widowed women, enhancing their sense of belonging and access to social support, crucial elements for mental health. Figure 1 illustrates the energy ladder model, which categorizes traditional fuels like crop waste and dung as typical for low-income groups, whereas electricity is more common among higher-income brackets. However, the adoption of clean cookstoves faces several obstacles, such as the high expense of the stoves, scarce availability of clean fuels, and cultural preferences for conventional cooking methods (Guta et al., 2022; Kebede, Tolossa & Tefera, 2022; Nwaka, Uma & Ike, 2020). To overcome these barriers, strategies like financial incentives, awareness campaigns, and community engagement initiatives have been suggested (Obele, 2020; Olaosebikan et al., 2019). Further research is needed to assess

the long-term effects of clean cookstove adoption on mental health and to tackle the identified adoption barriers.

Table : 1 Production and sourcing of clean household fuels (Puzzolo et. al., 2019)

	LPG	Biogas	Alcohol fuels	Compressed biomass pellets	Grid electricity	Photovoltaic electricity
Production	By-product of natural gas extraction and oil refining. Production starts at gas and oil wells where liquids are separated.	Animal and vegetable waste converted, typically in a household scale biodigester, to methane and piped directly into household appliance	<i>Ethanol</i> : biomass fermentation using feedstocks rich in sugar or starch or cellulose; <i>Methanol</i> : gas synthesis from CO ₂ , CO and H ₂ obtained from biomass or fossil fuels.	Wood, straw, sawdust or other wood or plant-based material, compressed using mechanical equipment.	Generated by electric power plants using natural gas, coal, solar, wind, hydro or other sources of energy.	Generated by photovoltaic cells.
Sourcing	Local when LPG produced domestically; most often imported through complex supply chains.	Highly localized	Local when existing feedstock available, often produced from residuals; imported in some cases.	Local when existing feedstock available, often produced from residuals; imported in rare cases.	National scale infrastructure for grid connections; more localized sourcing for off-grid unless distributed generation feasible	Household level or scaled to municipal installations of smaller or larger sizes.

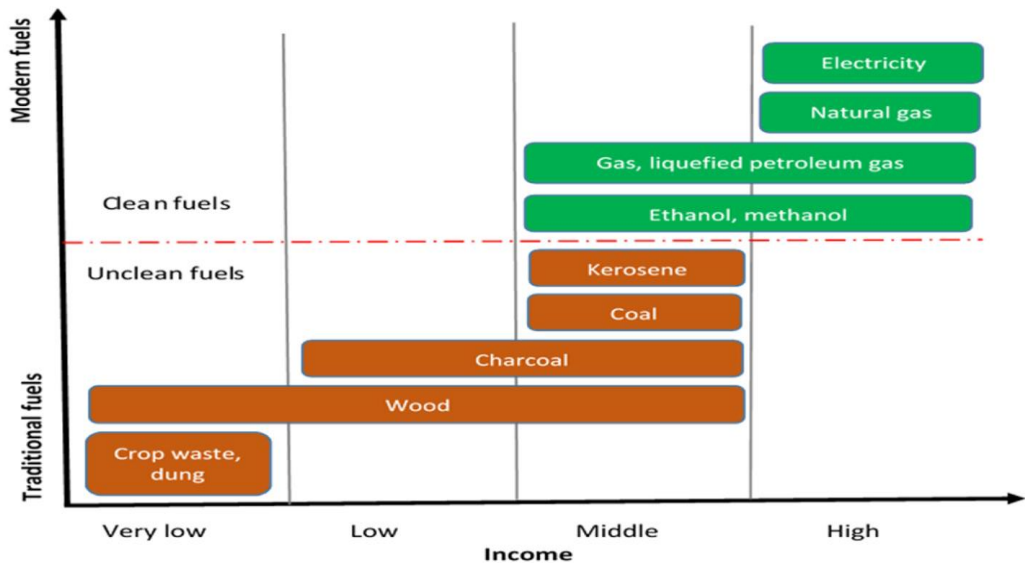


Figure 1: The energy ladder model (Dongzagla & Adams, 2022).

In summary, the analysis underscores the potential of clean cookstove adoption to improve the mental well-being of widowed women in Nigeria. By addressing the existing challenges, stakeholders can enhance the adoption rates of clean cookstoves and contribute to the mental health and overall well-being of these women.

3.1 The trend and distribution of literature on clean cookstove adoption

There has been a noticeable increase in the number of studies and publications on clean cookstove adoption and its impact on mental well-being among widowed women in Nigeria over the past decade (Hailemariam, Kalsi & Mavisakalyan, 2023, Nnagbo, 2023). This trend reflects a growing recognition of the importance of addressing indoor air pollution and its effects on health and well-being. Research on clean cookstove adoption among widowed women in Nigeria is distributed across various regions of the country. While some studies focus on urban areas, others examine rural and peri-urban communities, highlighting the diverse contexts in which clean cookstove initiatives are implemented. Literature on clean cookstove adoption and mental well-being among widowed women in Nigeria spans multiple disciplines, including public health, environmental science, social work, and gender studies (Greno, 2018, Owiyo, 2022, Yakubu, 2022). This interdisciplinary approach reflects the complex nature of the issue and the need for holistic solutions. Many studies in the literature focus on evaluating the effectiveness of intervention strategies aimed at promoting clean cookstove adoption among widowed women. These interventions may include financial incentives, awareness

campaigns, capacity-building programs, and policy initiatives. The literature includes both qualitative and quantitative research, allowing for a comprehensive understanding of the factors influencing clean cookstove adoption and its impact on mental well-being among widowed women. Qualitative studies often explore the lived experiences and perceptions of widowed women, while quantitative studies assess the outcomes and effectiveness of interventions (Holm, Berland & Severinsson, 2019, Peddie, et. al., 2021). There is evidence of collaborative research efforts involving government agencies, NGOs, academic institutions, and international organizations. These collaborative efforts help leverage resources, expertise, and networks to address complex challenges and promote sustainable solutions. Overall, the trend and distribution of literature on clean cookstove adoption as a pathway to enhancing mental well-being among widowed women in Nigeria reflect a growing interest in the topic and a multidimensional approach to addressing the issue (Mohammed, 2018, Nordin, et. al., 2023). Continued research and collaboration are essential for advancing knowledge, informing policy and practice, and improving the lives of widowed women in Nigeria.

Some studies in the literature highlight the gender and social dynamics that influence clean cookstove adoption among widowed women in Nigeria (Enworo & Njemanze, 2022, Odo, et. al., 2021, Otieno, 2019). These dynamics include women's roles and responsibilities within the household, access to decision-making power, and social norms related to cooking practices. Understanding these dynamics is crucial for designing effective interventions that empower widowed women to adopt clean cookstoves. The literature also explores the health and well-being outcomes of clean cookstove adoption among widowed women in Nigeria. Studies have found that adopting clean cookstoves can lead to improvements in respiratory health, reduced exposure to harmful pollutants, and enhanced overall well-being (Kyayesimira & Florence, 2021, Phillip, et. al., 2023, Van Gemert, et. al., 2019). These findings underscore the importance of clean cookstove adoption as a holistic approach to improving health outcomes among widowed women.

Several studies discuss the policy implications of clean cookstove adoption for enhancing mental well-being among widowed women in Nigeria. These implications include the need for supportive policies and regulations that promote clean cookstove adoption, as well as the importance of integrating clean cookstove initiatives into broader health and development agendas. Community participation and engagement are key themes in the literature, with many studies emphasizing the importance of involving communities in clean cookstove adoption initiatives (McCarron, et. al., 2020, Sesan, et. al., 2018). Community participation can help ensure the sustainability and effectiveness of interventions by building local capacity and fostering a sense of ownership among community members. Despite the benefits of clean cookstove adoption, the literature also

highlights various barriers and challenges that hinder widowed women's access to and use of clean cookstoves (Dianne, 2018, Guta, et. al., 2022, Otieno, 2019). These barriers include financial constraints, limited access to clean fuels, lack of awareness, and cultural norms. Addressing these barriers is essential for promoting widespread adoption of clean cookstoves among widowed women in Nigeria. The literature identifies several areas for future research, including longitudinal studies to assess the long-term impact of clean cookstove adoption on mental well-being, comparative studies to evaluate the effectiveness of different intervention strategies, and studies that explore the intersectionality of gender, socio-economic status, and other factors in clean cookstove adoption (Barrington-Leigh, et. al., 2019, Kyayesimira & Florence, 2021). In conclusion, the literature on clean cookstove adoption as a pathway to enhancing mental well-being among widowed women in Nigeria is diverse and multidimensional. By addressing the trends and distribution of this literature, researchers and policymakers can gain valuable insights into the factors influencing clean cookstove adoption and develop targeted interventions to improve the lives of widowed women in Nigeria.

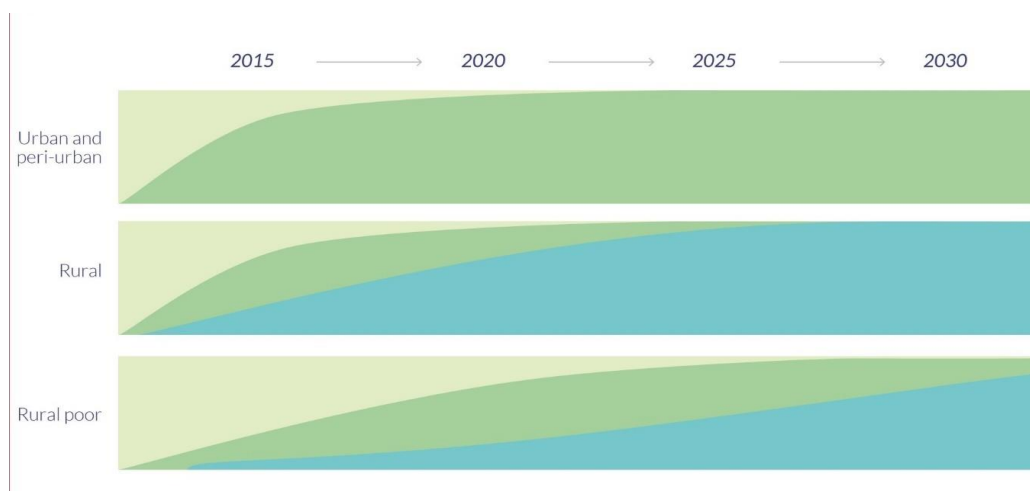


Figure 2: Hypothetical scenarios for rates of transition from traditional biomass use to low-emissions biomass and clean fuels across different groups (WHO, 2016)

3.2 The global outlook of research output on clean cookstove adoption

The global perspective on research concerning the adoption of clean cookstoves as a means to improve mental well-being among widowed women in Nigeria indicates a rising awareness and interest in this issue worldwide. Although much of the research is geographically focused, there is an expanding body of work that explores the wider

implications and obstacles associated with clean cookstove adoption for widowed women in low- and middle-income nations. Figure 2 illustrates hypothetical scenarios for transitioning from traditional biomass use to low-emission biomass and clean fuels among various groups (WHO, 2016). This figure visually represents the potential rates of transition across different demographics. Research on the adoption of clean cookstoves and its effects on the mental health of widowed women varies by region, with a significant number of studies conducted in areas experiencing high levels of indoor air pollution and limited access to clean cooking technologies, such as sub-Saharan Africa and South Asia. Nonetheless, interest is growing in other regions like Latin America and Southeast Asia, where clean cookstove adoption is also pertinent. Studies focusing on Nigerian widowed women frequently compare their situations with those in other countries, offering cross-cultural insights into the challenges and potential solutions related to clean cooking practices (Bonvillain, 2020; Sa'ad, 2024). These studies underscore the global relevance of the issue and emphasize the necessity for tailored interventions.

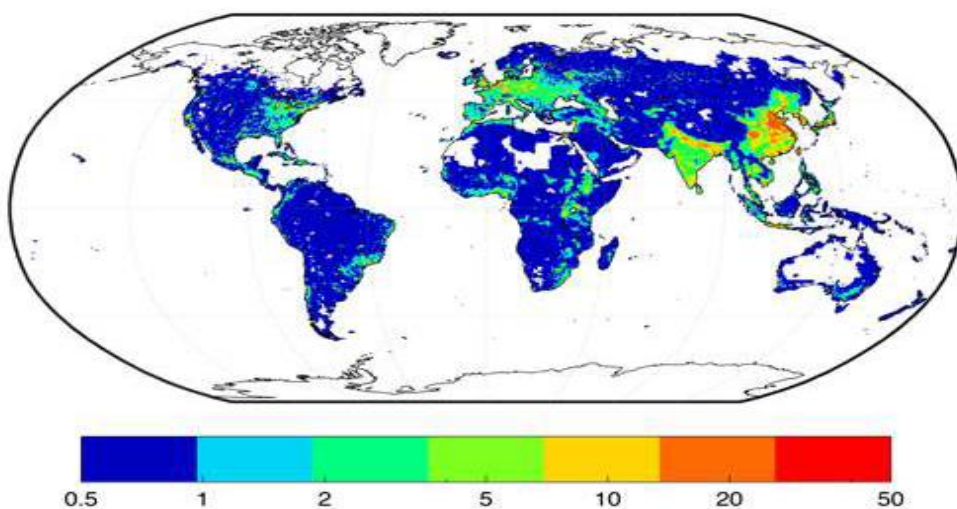


Figure 3: Global black carbon emissions from residential combustion, in Gigagrams (Gg) (WHO, 2016)

Research on clean cookstove adoption has also played a crucial role in shaping global policy debates and advocacy campaigns aimed at encouraging the use of clean cooking solutions among widowed women and other vulnerable groups (Gill-Wiehl, Ray & Kammen, 2021; Karanja & Gasparatos, 2019). This body of research has supported initiatives like the Global Alliance for Clean Cookstoves, which advocates for the widespread adoption of clean cooking technologies. Additionally, the research has spurred technological advancements in the field of clean cooking, with experts developing

more cost-effective, efficient, and eco-friendly cookstoves. These innovations hold the promise of substantially enhancing the quality of life for widowed women and other users of clean cookstoves. Figure 3 displays global black carbon emissions originating from residential sources. Studies on the adoption of clean cookstoves are closely linked to multiple Sustainable Development Goals (SDGs), such as SDG 3 (ensuring good health and well-being), SDG 5 (promoting gender equality), and SDG 7 (providing affordable and clean energy). By tackling the health risks, gender disparities, and energy access issues tied to conventional cooking methods, the adoption of clean cookstoves plays a vital role in advancing these global objectives (ESCAP, 2023; Onah, Nyong & Ayuba, 2021). In summary, the global perspective on research into clean cookstove adoption as a strategy to improve mental well-being among widowed women in Nigeria highlights the increasing acknowledgment of the significance of clean cooking solutions for enhancing health, well-being, and gender equity on a global scale. By addressing the challenges and opportunities related to clean cookstove adoption, researchers and policymakers can collaborate to build a healthier, more sustainable future for everyone.

4.0 The Context of Cooking Practices in Nigeria

In Nigeria, cooking transcends being a mere daily task; it is a cultural tradition deeply rooted in societal norms and heritage. For widowed women, traditional cooking methods often mirror these cultural practices, varying significantly across regions, ethnic groups, and socio-economic backgrounds. Recognizing the context of these cooking practices is essential for identifying the difficulties widowed women encounter and the potential avenues for meaningful intervention. As illustrated in Figure 4, biomass in Nigeria is derived from various sources, including agricultural residues, municipal waste, animal dung, and other materials. Widowed women in Nigeria commonly rely on traditional cooking techniques that utilize solid fuels like firewood, charcoal, or crop residues, often burned in open fires or basic stoves (Bebeteidoh, 2022; Bogale & Wondogenet, 2020; Guta et al., 2022). These methods, handed down through generations, are frequently viewed as the most economical and accessible options. However, they carry substantial health, environmental, and socio-economic consequences. A primary concern is indoor air pollution, as the smoke generated from burning solid fuels releases harmful pollutants such as carbon monoxide, particulate matter, and volatile organic compounds. Prolonged exposure to these pollutants can cause respiratory diseases, eye irritation, and other health complications (Shen et al., 2021; Tran, Park & Lee, 2020). Widowed women, who often bear the responsibility of cooking for their households, are especially susceptible to these health hazards. Additionally, traditional cooking methods demand considerable time and physical effort. Gathering firewood or charcoal can be labor-intensive and time-

consuming, particularly for widowed women who may face mobility constraints or limited access to resources (Dianne, 2018; Jagoe et al., 2020; Njenga et al., 2024). This burden can negatively affect their mental well-being, as the disproportionate responsibility of cooking leaves little time for rest, self-care, or other pursuits. Moreover, traditional cooking practices exacerbate environmental issues, including deforestation. Nigeria ranks among the countries with the highest deforestation rates globally, driven largely by the demand for firewood and charcoal. This environmental degradation not only impacts widowed women and their communities but also contributes to broader

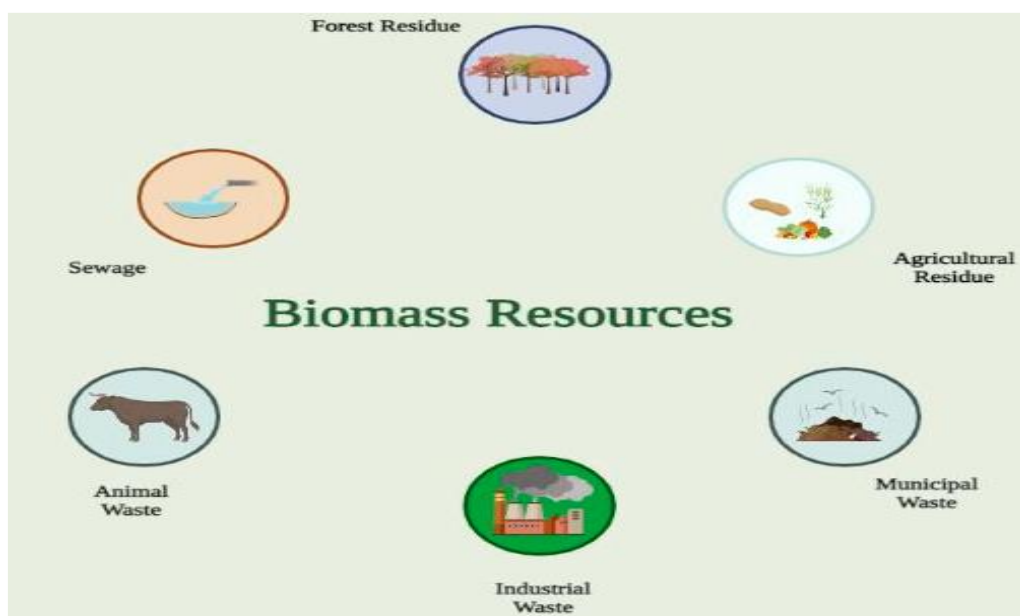


Figure 4. Biomass sources in Nigeria (Łaska & Ige, 2023).

climate change challenges. As depicted in Figure 5, wood accounts for more than 60% of household fuel usage across Africa. Given these challenges, there is increasing acknowledgment of the need to shift toward cleaner, more sustainable cooking technologies, such as improved cookstoves and alternative fuels. By understanding the specific cooking practices of widowed women in Nigeria, more targeted and effective interventions can be designed to enhance their health, well-being, and overall quality of life.

4.1 Health and environmental implications of traditional cooking methods

In Nigeria, traditional cooking methods, which often involve the use of solid fuels like firewood, charcoal, and crop residues, have significant health and environmental

implications (Ajibola, et. al., 2020, Akintan, Jewitt & Clifford, 2018, Łaska & Ige, 2023). These practices, while deeply ingrained in the culture and daily life of many communities, contribute to a range of health problems and environmental challenges. The burning of solid fuels in poorly ventilated spaces releases harmful pollutants such as carbon monoxide, particulate matter, and volatile organic compounds. Prolonged exposure to these pollutants can lead to respiratory diseases, including acute respiratory infections,

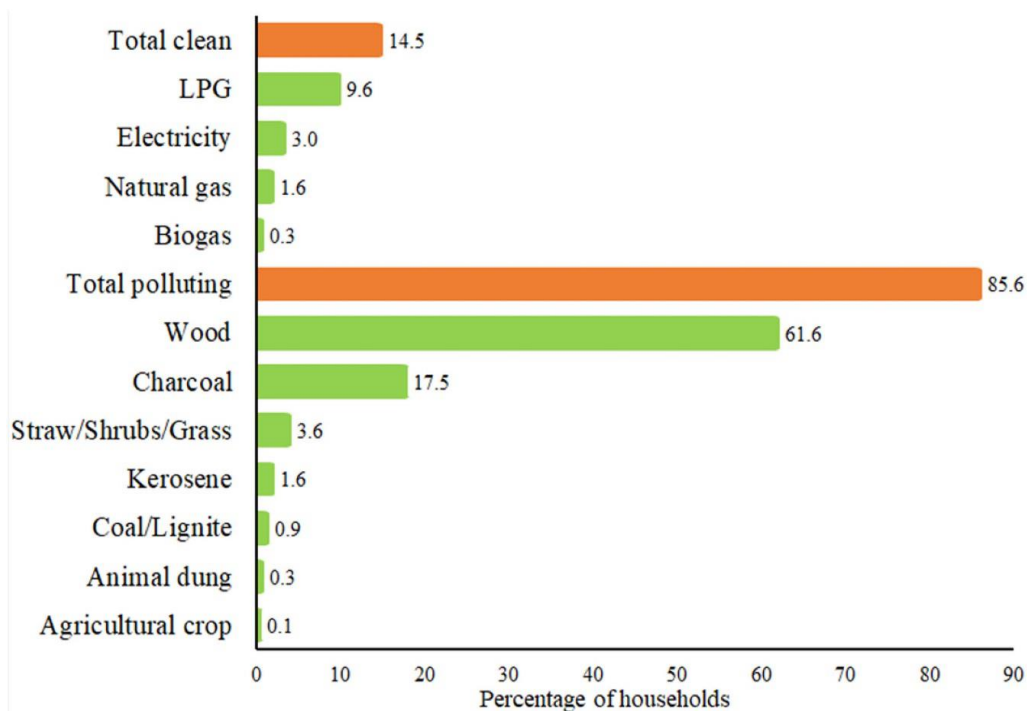


Figure 5: Percentage of households ($n = 302\ 786$) with the type of fuels primarily used for cooking in Africa (Odo, et al 2021).

chronic obstructive pulmonary disease (COPD), and lung cancer. Women and children, who are often responsible for cooking and spend more time indoors, are particularly at risk. The smoke produced by traditional cooking methods can irritate the respiratory tract, leading to coughing, wheezing, and shortness of breath (Bede-Ojimadu & Orisakwe, 2020, Juntarawijit & Juntarawijit, 2019, Sana, et. al., 2019). Children under five years of age are especially vulnerable, as their developing lungs are more susceptible to damage from air pollution. The impact of various cooking methods on the health of users is tabulated in table 2.

Exposure to smoke from traditional cooking fires can also cause eye irritation, redness, and discomfort. Prolonged exposure may contribute to the development of cataracts and other eye conditions. In poorly ventilated spaces, the incomplete combustion of solid fuels can lead to the production of carbon monoxide, a colorless and odorless gas that can be deadly if inhaled in high concentrations.

Table 2: Assumptions on efficiency levels and health effects of various cooking technologies (Dagnachew, et. al., 2019)

Fuel	Cookstove technology	Conversion efficiency (%)			24-hour PM2.5 concentrations ($\mu\text{g}/\text{m}^3$)		
		2015	2030	2050	2015	2030	2050
Traditional biomass	Traditional cookstove	12	14	20	500	500	500
	Improved cookstove	30	33	40	200	150	75
Modern biomass	Advanced cookstove	40	47	65	75	60	35
Coal	Improved coal cookstove	25	25	25	200	150	75
Kerosene	Kerosene stove	35	44	55	50	40	20
LPG	Single or double burner	50	58	70	20	10	5
Natural gas	Gas stove	50	57	66	0	0	0
Biogas	Gas stove & digester	40	50	65	0	0	0
Electricity	Electric/ induction	75	86	90	0	0	0

The demand for firewood and charcoal for cooking has contributed to deforestation in Nigeria, leading to loss of biodiversity, soil erosion, and habitat destruction (Mba, 2018, Okorondu, et. al., 2022, Wajim, 2020). Burning solid fuels releases carbon dioxide and other greenhouse gases into the atmosphere, contributing to global climate change as shown in figure 6. The smoke from traditional cooking fires contributes to outdoor air pollution, affecting not only the health of local communities but also regional air quality. In conclusion, traditional cooking practices in Nigeria have significant health and environmental implications. Transitioning to cleaner and more sustainable cooking technologies, such as clean cookstoves and alternative fuels, is essential to reducing the negative impact of cooking on health and the environment (Adhikari, et. al., 2020, Jung & Huxham, 2018, Nizami, Ahmad & Latif, 2023, Ravindra, Kaur-Sidhu & Mor, 2021).

4.2 Socio-economic challenges associated with traditional cooking practices

In Nigeria, traditional cooking practices are often associated with several socio-economic challenges, particularly for widowed women who may already be vulnerable due to the loss of their spouse (Eteng, 2022, Nwokoro & Ogba, 2019, Shahin, 2022).

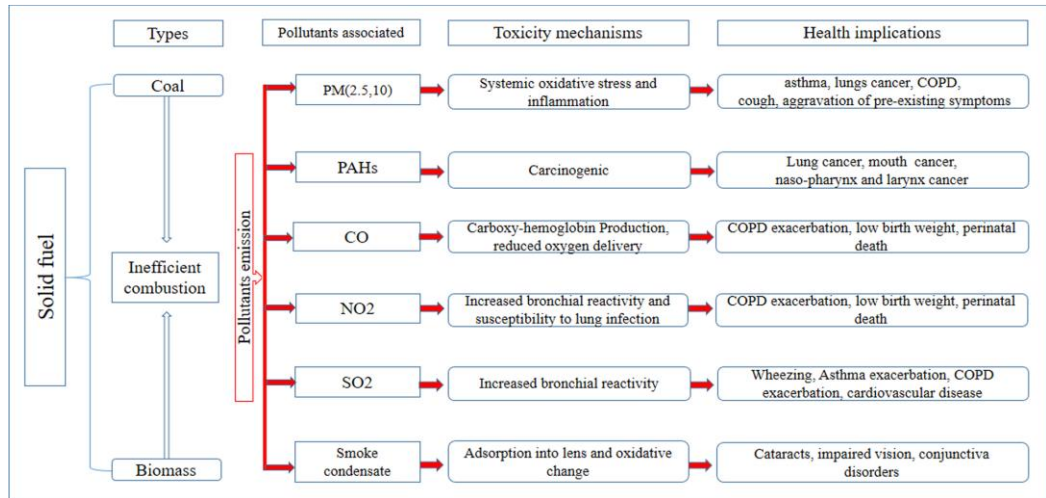


Figure 6: Pollutants associated with solid fuel, possible mechanisms of toxicity and health impacts (Ali et. al., 2021).

These challenges stem from the reliance on solid fuels such as firewood and charcoal for cooking, which can have a range of negative impacts on the economic well-being of widowed women and their families. Collecting firewood or charcoal can be a time-consuming and physically demanding task, especially in areas where these resources are scarce. For widowed women who are often responsible for cooking, this can take away time from other activities, including income-generating opportunities or caring for their families.

The use of solid fuels for cooking is associated with indoor air pollution, which can lead to respiratory illnesses and other health problems (Ali, et. al., 2021, Balmes, 2019, Guercio, et. al., 2021). The costs associated with treating these illnesses can place a financial burden on widowed women and their families, particularly if they do not have access to affordable healthcare services. The demand for firewood and charcoal for cooking contributes to deforestation and environmental degradation. This can have long-term consequences for the availability of these resources, as well as the overall health of the environment. The time and effort spent on collecting firewood or charcoal could be used for income-generating activities. For widowed women who may already be

struggling financially, this lost opportunity for income can further exacerbate their economic challenges. In many Nigerian communities, cooking is seen as a primarily female responsibility. This can limit widowed women's opportunities for economic empowerment and participation in decision-making processes within their households and communities.

The time spent on cooking and collecting firewood or charcoal can also impact widowed women's ability to access education, either for themselves or for their children. This can perpetuate cycles of poverty and limit opportunities for social mobility. In conclusion, traditional cooking practices in Nigeria can exacerbate existing socio-economic challenges faced by widowed women. Transitioning to cleaner and more sustainable cooking technologies can not only improve their health and well-being but also empower them economically and socially.

5.0 The Role of Clean Cookstoves in Improving Mental Well-being

The adoption of clean cookstoves is instrumental in enhancing the mental well-being of individuals, especially widowed women in Nigeria. Shifting from conventional cooking techniques to clean cookstoves can positively influence mental health in multiple ways, both directly and indirectly, by alleviating various difficulties encountered by widowed women. Clean cookstoves markedly decrease indoor air pollution in comparison to traditional methods (Islam et al., 2022; Pratiti et al., 2020; Pratiti, 2021). This decline in harmful emissions such as carbon monoxide and particulate matter can enhance respiratory health, lowering the likelihood of respiratory ailments and the discomfort associated with smoke inhalation. This improvement can foster a sense of comfort and well-being within the household.

Clean cookstoves are more efficient and demand less time and effort to use than traditional stoves (Aemro, Moura & de Almeida, 2021; Pande, Kalamkar & Kshirsagar, 2019; Wright, Sathre & Buluswar, 2020). This efficiency can afford widowed women additional time to partake in activities that bolster their mental health, such as family interactions, hobbies, or income-generating endeavors. Moreover, clean cookstoves can aid in economic empowerment by cutting down on fuel expenses and the time allocated to gathering firewood or charcoal. This can offer widowed women greater financial resources and stability, thereby diminishing stress and anxiety linked to financial uncertainty.

Clean cookstoves also play a part in environmental preservation by curbing deforestation and greenhouse gas emissions (Manaye et al., 2022; Rosenthal et al., 2018; Sundberg et

al., 2020). The awareness that their cooking practices are eco-friendly can instill a sense of pride and well-being in widowed women, encouraging a positive perspective on their environmental impact. Additionally, the adoption of clean cookstoves can empower widowed women within their communities. By championing clean cooking practices, they can heighten awareness about the significance of environmental sustainability and health, cultivating a sense of purpose and empowerment.

In summary, clean cookstoves serve a multifaceted role in boosting the mental well-being of widowed women in Nigeria. By tackling health, economic, and environmental challenges, clean cookstoves can pave the way for a healthier, more sustainable, and empowered future for widowed women, ultimately improving their mental well-being and quality of life.

5.1 Definition and types of clean cookstoves

Clean cookstoves are innovative cooking appliances engineered to burn fuel more efficiently and with fewer emissions compared to conventional stoves, thereby enhancing indoor air quality and reducing environmental harm (Lahai et al., 2022; Mutua, 2022; Wright, Sathre, & Buluswar, 2020). These stoves come in various designs, each tailored to specific fuel types and user needs. Some prominent categories include:

1. **Enhanced Biomass Stoves** : These stoves are optimized to burn biomass fuels like wood, agricultural waste, or animal dung more effectively than traditional open fires. They typically incorporate features such as insulation, advanced combustion chambers, and chimneys to minimize smoke output and maximize heat efficiency.
2. **Liquefied Petroleum Gas (LPG) Stoves** : LPG stoves rely on liquefied petroleum gas, a cleaner-burning fuel, for operation. They are user-friendly, require minimal maintenance, and emit little smoke or pollutants. However, the cost and availability of LPG can be a hurdle in certain regions.
3. **Electric Stoves** : Powered solely by electricity, these stoves eliminate the need for conventional fuels. While they are clean and convenient, their practicality is often limited by high costs and inconsistent electricity access, particularly in rural areas.
4. **Solar Cookers** : Utilizing solar energy, these devices cook food without relying on traditional fuels. They are eco-friendly and ideal for sun-rich regions, though their effectiveness is reduced during nighttime or cloudy conditions.

5. Ethanol Stoves : These stoves burn ethanol, a clean fuel sourced from renewable materials like sugarcane or corn. They emit little smoke and represent a sustainable option, but the availability and affordability of ethanol can be problematic in some areas.

6. Biogas Stoves : Biogas stoves use biogas, a renewable fuel generated from organic waste, as their energy source. They are environmentally beneficial and help curb methane emissions from waste decomposition. However, the infrastructure needed for biogas production and distribution can hinder widespread adoption.

In summary, clean cookstoves provide numerous advantages, such as better indoor air quality, reduced fuel use, and lower greenhouse gas emissions. They are instrumental in advancing sustainable cooking methods and enhancing the health and quality of life for users, particularly widowed women in Nigeria.

5.2 Benefits of clean cookstove adoption for mental well-being

The adoption of clean cookstoves brings numerous advantages for mental well-being, especially for widowed women in Nigeria. These benefits can profoundly enhance their quality of life and overall sense of fulfillment. A key advantage of clean cookstoves is the substantial decrease in indoor air pollution compared to conventional cooking methods. By utilizing cleaner fuels and more efficient combustion techniques, clean cookstoves emit less smoke and fewer harmful pollutants (Adane et al., 2020; Karanja & Gasparatos, 2019). This reduction in indoor air pollution can lead to better respiratory health, lowering the risk of smoke-related illnesses and discomfort. Such improvements can foster a greater sense of well-being and comfort within the household.

Clean cookstoves are also more efficient, requiring less time and effort to use than traditional stoves (Aemro, Moura & de Almeida, 2021; Wright, Sathre & Buluswar, 2020). This efficiency allows widowed women to dedicate more time to activities that enhance their mental well-being, such as bonding with family, pursuing personal interests, or engaging in income-generating work. The time saved from gathering firewood or charcoal can also promote economic independence, as women can allocate this time to productive endeavors or self-care.

In addition to physical and economic benefits, clean cookstove adoption can positively impact the psychological well-being of widowed women. The knowledge that they are using cleaner and more efficient cooking methods can instill a sense of pride and achievement (Jagoe et al., 2020; Kar et al., 2019; Northrup, 2021). Furthermore, the enhanced cooking experience—characterized by reduced smoke and faster cooking times—can make the process less stressful and more enjoyable, alleviating the frustrations

often associated with traditional methods. In summary, the adoption of clean cookstoves can significantly boost the mental well-being of widowed women in Nigeria by minimizing indoor air pollution, saving time and effort, and offering psychological benefits linked to cleaner and more efficient cooking practices.

6.0 Environmental and Societal Implications of Clean Cookstove Adoption

The adoption of clean cookstoves carries profound environmental and social benefits, especially in regions like Nigeria, where conventional cooking practices are linked to deforestation, indoor air pollution, and health issues (Aemro, Moura, & de Almeida, 2021; Oluwatosin, Ola, & Olayinka, 2022; Onyeneke et al., 2019). Shifting to clean cookstoves offers a viable solution to these challenges, fostering positive outcomes for both the environment and society. Traditional cooking methods, which often depend on firewood and charcoal, contribute to forest degradation and habitat destruction. Clean cookstoves, designed for greater efficiency and the use of cleaner fuels, can lower the reliance on wood-based fuels, thereby curbing deforestation and supporting biodiversity conservation.

The combustion of solid fuels for cooking releases greenhouse gases, worsening climate change. Clean cookstoves, by emitting fewer pollutants, play a role in mitigating climate change and its adverse environmental effects. Additionally, these stoves significantly reduce indoor air pollution, leading to better respiratory health and a decreased risk of related illnesses (Qiu et al., 2022; Raju, Siddharthan, & McCormack, 2020; Simkovich et al., 2019). This improvement is particularly impactful for women and children, who are disproportionately affected by poor indoor air quality. In many communities, women bear the primary responsibility for cooking, which can be labor-intensive and time-consuming with traditional methods. Clean cookstoves can alleviate this burden, freeing up time for women to engage in education, employment, or community activities.

Households can also achieve cost savings by adopting clean cookstoves, as cleaner fuels tend to be more efficient and economical over time. This financial benefit can enhance the economic stability of vulnerable households, such as those led by widowed women or single mothers. Furthermore, the widespread use of clean cookstoves can promote community development by easing the strain on natural resources and fostering environmental sustainability (Alem, 2021; Karanja & Gasparatos, 2019; Ravindra, Kaur-Sidhu, & Mor, 2021). It can also spur innovation and entrepreneurial opportunities within the clean cooking sector. In summary, the transition to clean cookstoves has the potential

to drive sustainable development, improve public health, and enhance the overall quality of life for individuals and communities.

6.1 Contribution to environmental sustainability

The adoption of clean cookstoves plays a vital role in advancing environmental sustainability by tackling two critical challenges: curbing deforestation and reducing greenhouse gas emissions. In many regions, including Nigeria, traditional cooking methods depend heavily on firewood and charcoal, which drive deforestation and the destruction of natural habitats. By transitioning to clean cookstoves, which are more efficient and utilize cleaner fuels like Liquefied Petroleum Gas (LPG) or biofuels, the reliance on wood-based fuels can be significantly diminished (Aemro, Moura & de Almeida, 2021; Karanja & Gasparatos, 2019; Olowolayemo, 2023). This shift can ease the strain on forests and ecosystems, safeguarding biodiversity and encouraging sustainable land management practices.

The combustion of solid fuels for cooking releases greenhouse gases, including carbon dioxide (CO₂) and methane (CH₄), into the atmosphere, exacerbating global climate change. Clean cookstoves, however, emit fewer pollutants because they burn fuel more efficiently and produce less smoke (Rasoulkhani et al., 2018; Wright, Sathre & Buluswar, 2020). By embracing clean cookstoves, households can lower their carbon footprint and support worldwide initiatives to combat climate change.

In summary, the widespread use of clean cookstoves can have a profound positive effect on environmental sustainability. It helps protect forests, reduces greenhouse gas emissions, and fosters more sustainable cooking practices globally.

6.2 Empowerment and advocacy opportunities for widowed women

Empowerment and advocacy opportunities for widowed women through the adoption of clean cookstoves are crucial for promoting sustainable practices and improving their overall well-being (Ardrey, 2020, Clancy, et. al., 2019, Lane, Dhal & Srivastava, 2021). These opportunities not only empower widowed women but also benefit their communities and the environment. Widowed women who adopt clean cookstoves can become advocates for clean energy in their communities. By sharing their experiences and the benefits of clean cookstoves, they can raise awareness about the importance of sustainable cooking practices and encourage others to make the switch. This advocacy

can lead to broader adoption of clean cookstoves in the community, further reducing environmental impact and improving health outcomes.

Participation in sustainable practices such as clean cookstove adoption can provide widowed women with a sense of purpose and belonging (Amoak, Najjar & Kyle, 2022, DiPrete Brown, et. al., 2020, Galappaththi, et. al., 2021). Engaging in activities that benefit the environment and the community can foster a sense of pride and accomplishment, boosting their self-esteem and overall well-being. Additionally, being part of a larger movement towards sustainability can create a sense of belonging and connection to others who share similar values. Overall, empowerment and advocacy opportunities for widowed women through clean cookstove adoption can have far-reaching benefits, including improved environmental sustainability, enhanced community engagement, and increased well-being for widowed women and their communities.

7.0 Strategies for Promoting Clean Cookstove Adoption Among Widowed Women

Promoting clean cookstove adoption among widowed women requires a combination of targeted strategies that address the unique challenges they face (Nabukwangwa, et. al., 2023, Ochieng, et. al., 2020, Otieno, 2019). These strategies should aim to raise awareness, improve accessibility, and provide support for widowed women to transition to clean cooking technologies. Launch targeted awareness campaigns to educate widowed women about the health, environmental, and economic benefits of clean cookstoves. These campaigns can include community events, workshops, and informational materials tailored to the specific needs and preferences of widowed women. Provide training and capacity-building programs to widowed women on the use and maintenance of clean cookstoves. Empowering them with the knowledge and skills to effectively use clean cookstoves can increase adoption rates and ensure long-term sustainability (Del Rio, et. al., 2020, Karanja & Gasparatos, 2019, Lindgren, 2020).

Offer financial incentives such as subsidies or microfinance options to make clean cookstoves more affordable for widowed women. This can help overcome financial barriers and encourage widowed women to make the switch to clean cooking technologies. Collaborate with local organizations, government agencies, and community leaders to promote clean cookstove adoption among widowed women. Partnerships can help leverage resources, reach a wider audience, and ensure the sustainability of clean cooking programs.

Provide tailored support services such as after-sales support, repair services, and access to spare parts to ensure that widowed women can easily maintain their clean cookstoves.

This can help build trust in the technology and increase adoption rates. Facilitate peer-to-peer networks and support groups for widowed women who have adopted clean cookstoves. These networks can provide emotional support, share experiences, and serve as advocates for clean cooking in their communities.

Advocate for supportive policies at the local and national levels that promote clean cookstove adoption among widowed women. This can include tax incentives, subsidies, and regulations that prioritize clean cooking technologies. By implementing these strategies, stakeholders can effectively promote clean cookstove adoption among widowed women, leading to improved health, environmental sustainability, and economic empowerment (Dutta & Sahu, 2024, Kebede, Tolossa & Tefera, 2022, Pye, et. al., 2020).

7.1 Awareness campaigns and education initiatives

Awareness campaigns and education initiatives are essential components of clean cookstove adoption programs aimed at enhancing the mental well-being of widowed women in Nigeria (Barkema, Bindl & Tanveer, 2023, Garrison, 2021, Makanga, 2022). These campaigns and initiatives are designed to raise awareness about the benefits of clean cookstoves, educate widowed women about their use and maintenance, and promote behavior change towards cleaner cooking practices. Here are some examples of effective awareness campaigns and education initiatives:

Organizing workshops and demonstrations in local communities can help raise awareness about the benefits of clean cookstoves. These events can provide widowed women with hands-on experience using clean cookstoves and demonstrate their effectiveness in reducing smoke and improving indoor air quality. Providing informational materials, such as brochures, posters, and pamphlets, can help educate widowed women about the health, environmental, and economic benefits of clean cookstoves. These materials can be distributed during community events or through local health centers and community organizations.

Implementing training programs that focus on the use and maintenance of clean cookstoves can empower widowed women to adopt and sustain cleaner cooking practices (Dianne, 2018, Katutsi, et. al., 2023, Otieno, 2019). These programs can include practical demonstrations, cooking classes, and information on where to access clean fuels. Leveraging media channels, such as radio, television, and social media, can help reach a wider audience and raise awareness about clean cookstoves. Broadcasting radio programs or airing television commercials that highlight the benefits of clean cookstoves can be effective in reaching widowed women in both urban and rural areas.

Engaging widowed women who have already adopted clean cookstoves as advocates can be a powerful way to promote adoption. Peer-to-peer outreach programs can involve sharing personal stories, hosting community events, and providing support to encourage others to make the switch. Collaborating with local organizations, such as women's groups, community-based organizations, and health centers, can help amplify the impact of awareness campaigns and education initiatives. These organizations can help facilitate outreach and provide support to widowed women interested in adopting clean cookstoves.

Overall, awareness campaigns and education initiatives play a crucial role in promoting clean cookstove adoption among widowed women in Nigeria. By raising awareness, providing education, and empowering widowed women to make informed choices, these initiatives can contribute to enhancing their mental well-being and overall quality of life.

7.2 Financial incentives and subsidies for clean cookstove acquisition

Financial incentives and subsidies are key strategies for promoting the acquisition of clean cookstoves among widowed women in Nigeria (Iro & Danlami, 2022, Kebede, Tolossa & Tefera, 2022, Otieno, 2019). These incentives help reduce the upfront cost of clean cookstoves, making them more accessible and affordable. Here are some examples of financial incentives and subsidies that can encourage clean cookstove adoption: Government subsidies can be provided to reduce the cost of clean cookstoves for widowed women. These subsidies can be targeted specifically at low-income households or vulnerable groups, such as widowed women, to ensure affordability. Subsidies can be provided in the form of direct cash transfers, vouchers, or discounts on the purchase of clean cookstoves.

Microfinance programs can provide widowed women with access to affordable loans to purchase clean cookstoves (Abokyi, et. al., 2024, Nabukwangwa, et. al., 2023, Neto-Bradley, et. al., 2021). These loans can be repaid in small installments, making them more manageable for widowed women with limited financial resources. Microfinance programs can also provide financial literacy training to help widowed women make informed decisions about their finances. Rebate programs can offer widowed women a partial refund on the purchase of a clean cookstove after they have made the initial investment. This can incentivize widowed women to adopt clean cookstoves by reducing the overall cost of acquisition. Tax incentives can be provided to manufacturers, retailers, and consumers of clean cookstoves to promote their adoption. For example, governments can offer tax breaks or exemptions for the production, sale, or purchase of clean cookstoves, making them more attractive to widowed women.

NGOs and private sector organizations can partner with government agencies to provide financial incentives and subsidies for clean cookstove acquisition (Bisaga & To, 2021, Lietaer, Zaccai & Verbist, 2019, Quinn, et. al., 2018). These partnerships can leverage resources and expertise to ensure that financial incentives are effectively targeted and reach widowed women in need. Overall, financial incentives and subsidies are critical for promoting clean cookstove adoption among widowed women in Nigeria. By reducing the financial barriers to acquisition, these incentives can help improve the mental well-being of widowed women and contribute to sustainable development.

7.3 Support for infrastructure development and distribution networks

Support for infrastructure development and distribution networks is crucial for the successful adoption of clean cookstoves among widowed women in Nigeria (Clancy, et. al., 2019, Enworo & Njemanze, 2022, Onah, Nyong & Ayuba, 2021). Infrastructure development ensures that clean cookstoves are accessible and available to widowed women, while distribution networks help facilitate their adoption. Here are some ways in which support for infrastructure development and distribution networks can enhance the mental well-being of widowed women: Infrastructure development can help improve access to clean cookstoves for widowed women in remote and underserved areas (Doku-Marfo, 2022, Nabukwangwa, et. al., 2023, Neto-Bradley, et. al., 2021). This includes establishing distribution points, such as retail outlets or community centers, where widowed women can purchase or access clean cookstoves. Improving access ensures that widowed women have the opportunity to adopt clean cookstoves and benefit from their use. The benefits of using improved cookstoves is tabulated in table 3.

Table 3: An Overview of sociotechnical dimensions to improved cookstoves (Del Rio, ET. AL., 2020).

Dimension	Inclusive of	Examples
Technical	Technology and availability	Food preparation and ICS Performance
Financial	Cookstoves' prices and users' ability to afford	Capital cost of improved cookstoves, time- and costsavings
Socioenvironmental	Broad social and cost benefits	mitigation of greenhouse gas emissions, health improvements and deforestation prevention

Behavioural	Consumer and user perceptions and behaviours	Consumer perceptions of all of the above, including benefits, inconvenience, distrust, confusion, and range anxiety
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Distribution networks play a crucial role in ensuring the availability of clean cookstoves in the market (Perros, Tomei & Parikh, 2024, Robinson, et. al., 2022, Vassiliades, et. al., 2022). By establishing reliable distribution networks, clean cookstove manufacturers can reach widowed women in different parts of the country and ensure that they have access to a variety of clean cookstove options. This helps widowed women find a clean cookstove that suits their needs and preferences. Infrastructure development can also support training and capacity building initiatives for widowed women. This includes providing training on the use and maintenance of clean cookstoves, as well as educating widowed women about the benefits of clean cooking practices. By building capacity, infrastructure development can empower widowed women to adopt clean cookstoves and incorporate them into their daily lives.

Infrastructure development and distribution networks can support local economies by creating jobs and stimulating economic growth. This can have a positive impact on the mental well-being of widowed women by improving their economic prospects and providing them with opportunities for economic empowerment. Sustainable infrastructure development and distribution networks are essential for the long-term success of clean cookstove adoption programs (Karanja & Gasparatos, 2019, Lindgren, 2020, Puzzolo, et. al., 2019). This includes ensuring that distribution networks are efficient and cost-effective, and that infrastructure is maintained and upgraded as needed. Sustainable infrastructure development helps ensure that widowed women continue to have access to clean cookstoves and can benefit from their use in the long term.

Overall, support for infrastructure development and distribution networks is crucial for enhancing the mental well-being of widowed women in Nigeria through the adoption of clean cookstoves. By improving access, ensuring availability, and supporting capacity building initiatives, infrastructure development can empower widowed women to adopt clean cookstoves and improve their quality of life.

7.4 Collaboration between government agencies, NGOs, and the private sector

Effective collaboration among government agencies, non-governmental organizations (NGOs), and the private sector is critical for the successful implementation of clean

cookstove initiatives among widowed women in Nigeria (Clancy et al., 2019; Dumga & Goswami, 2023; Joy Kellen, 2022). Each stakeholder contributes distinct resources and expertise, and their partnership enables a more holistic and impactful approach to advancing clean cookstove adoption. Below are several ways in which such collaboration can improve the mental well-being of widowed women:

Government agencies are instrumental in crafting policies and regulations that encourage the use of clean cookstoves (Astuti, Day & Emery, 2019; Ravindra, Kaur-Sidhu & Mor, 2021; Shari et al., 2022). NGOs and private sector entities can offer valuable insights based on their practical experience, ensuring that these policies are both feasible and effective. Additionally, NGOs and the private sector can mobilize essential resources, such as funding and technical knowledge, to support clean cookstove programs, while government agencies can provide financial incentives, regulatory frameworks, and other forms of assistance to facilitate adoption.

NGOs and the private sector can spearhead awareness campaigns and advocacy initiatives to highlight the advantages of clean cookstoves for widowed women (Apili, Tibasaaga & Hitimana, 2020; Herrera Cano, 2021; MacGregor, Arora-Jonsson & Cohen, 2022). Government agencies can bolster these efforts by supplying information, resources, and policy advocacy. Furthermore, NGOs and the private sector can organize training and capacity-building programs to educate widowed women on the proper use and maintenance of clean cookstoves, with government agencies offering technical and regulatory support to enhance these initiatives.

Collaboration among these stakeholders is also vital for monitoring and evaluating the effectiveness of clean cookstove programs (Clemens et al., 2018; Lindgren, 2020; Quinn et al., 2018). By working together, they can ensure that these programs are achieving their goals and addressing the specific needs of widowed women.

In summary, the partnership between government agencies, NGOs, and the private sector is indispensable for improving the mental well-being of widowed women in Nigeria through the adoption of clean cookstoves. By combining their strengths and resources, these stakeholders can collectively promote clean cooking solutions and enhance the lives of widowed women.

8.0 Case Studies and Success Stories

Several successful clean cookstove adoption programs have been implemented in Nigeria, targeting widowed women specifically. These programs have employed various strategies

to promote the adoption of clean cookstoves and have achieved significant success in improving the lives of widowed women. Here are some examples:

1. The Oando Foundation Clean Cookstove Initiative:

The Oando Foundation, in collaboration with local partners, implemented a clean cookstove initiative aimed at widowed women in rural communities in Nigeria. The program provided training on the benefits of clean cookstoves and offered subsidies to make them more affordable. The initiative also included community engagement activities to raise awareness and promote the adoption of clean cookstoves. As a result, many widowed women in these communities have switched to clean cookstoves, leading to improved health and well-being.

2. The Nigerian Alliance for Clean Cookstoves:

The Nigerian Alliance for Clean Cookstoves is a coalition of government agencies, non-governmental organizations, and private sector partners working to promote the adoption of clean cookstoves in Nigeria. The alliance has implemented several programs targeting widowed women, including awareness campaigns, training programs, and financial incentives. These programs have been successful in increasing the adoption of clean cookstoves among widowed women and have had a positive impact on their health and well-being.

3. The Global Alliance for Clean Cookstoves (GACC):

The GACC has also supported clean cookstove adoption programs in Nigeria, focusing on widowed women and other vulnerable groups. These programs have included capacity-building activities, market development initiatives, and policy advocacy efforts. By working with local partners and stakeholders, the GACC has been able to promote the adoption of clean cookstoves among widowed women in Nigeria and has contributed to improving their quality of life.

4. The Women's Initiative for Sustainable Environment (WISE):

WISE is a non-governmental organization in Nigeria that has implemented clean cookstove adoption programs targeting widowed women. The organization provides training and support to widowed women to help them adopt clean cookstoves and transition away from traditional cooking methods. WISE also works with local communities to raise awareness about the benefits of clean cookstoves and promote their adoption.

Overall, these examples demonstrate that successful clean cookstove adoption programs for widowed women in Nigeria require a combination of strategies, including training, financial incentives, community engagement, and policy support. By implementing these programs effectively, stakeholders can improve the lives of widowed women and promote sustainable cooking practices in Nigeria.

8.1 Evaluation of outcomes and impact on mental well-being

Assessing the effects and outcomes of clean cookstove adoption on the mental well-being of widowed women in Nigeria is crucial for determining the success of such programs (Igwe et al., 2020; Makanga, 2022; Sbaffi, Zamani & Kalua, 2023). Although specific research on this subject is limited, current studies and anecdotal reports indicate several beneficial results:

A key advantage of adopting clean cookstoves is the significant decrease in indoor air pollution, which enhances respiratory health (Pratiti et al., 2020; Qiu et al., 2022; Van Gemert et al., 2019). Widowed women who transition to clean cookstoves experience reduced exposure to harmful pollutants, thereby lowering the risk of respiratory diseases and the discomfort associated with smoke. This improvement can foster a sense of comfort and well-being in their living spaces.

Clean cookstoves are more efficient and require less time and effort to use compared to traditional stoves (Aemro, Moura & de Almeida, 2021; Pande, Kalamkar & Kshirsagar, 2019; Wright, Sathre & Buluswar, 2020). This efficiency allows widowed women more time to engage in activities that enhance their mental well-being, such as spending time with family, pursuing hobbies, or participating in income-generating activities. The time and effort saved from gathering firewood or charcoal can also enhance economic independence, alleviating stress and anxiety related to financial instability.

The adoption of clean cookstoves can empower widowed women by giving them greater control over their cooking practices and environment. This empowerment can boost self-esteem and a sense of agency, both of which are vital for mental well-being. Clean cookstove programs often include community engagement activities like training sessions and awareness campaigns (Clemens et al., 2018; Del Rio et al., 2020; Lindgren, 2020). These activities can help widowed women feel more connected to their communities, fostering a sense of belonging and social support, which are crucial for mental health.

Additionally, clean cookstove adoption can increase environmental awareness among widowed women (Gould et al., 2020; Kumar et al., 2020; Odo et al., 2021). Knowing that their cooking practices are environmentally friendly can instill a sense of pride and well-being, promoting a positive outlook on their environmental impact.

In summary, while further research is necessary to fully understand the impact of clean cookstove adoption on the mental well-being of widowed women in Nigeria, existing evidence points to several positive outcomes. By reducing indoor air pollution, saving time and effort, empowering women, and fostering community engagement, clean

cookstove adoption can significantly enhance the mental well-being of widowed women in Nigeria.

9.0 Challenges and Limitations

Although the adoption of clean cookstoves holds promise for improving the mental well-being of widowed women in Nigeria, several obstacles and limitations must be overcome to maximize its effectiveness (Daniyan, 2023; Owiyo, 2022; Sani & Scholz, 2022). Clean cookstoves are often more costly than traditional stoves, making them less accessible to widowed women, particularly those with limited financial means. The high initial expense of clean cookstoves can pose a significant hurdle to their adoption. Additionally, even if widowed women can afford the stoves, access to clean fuels like LPG or ethanol is often restricted in many regions of Nigeria. Without reliable access to clean fuels, widowed women may continue to depend on traditional fuels, undermining the advantages of clean cookstove adoption. A lack of awareness about the health, environmental, and economic benefits of clean cookstoves can also impede their adoption. Many widowed women may not understand the value of transitioning to clean cookstoves, which can reduce adoption rates (Guta et al., 2022; Kebede, Tolossa & Tefera, 2022; Pye et al., 2020; Schunder, 2020). Cooking practices are frequently tied to cultural traditions, and some widowed women may resist switching to clean cookstoves due to a preference for traditional methods or a belief that clean cookstoves conflict with their cultural norms.

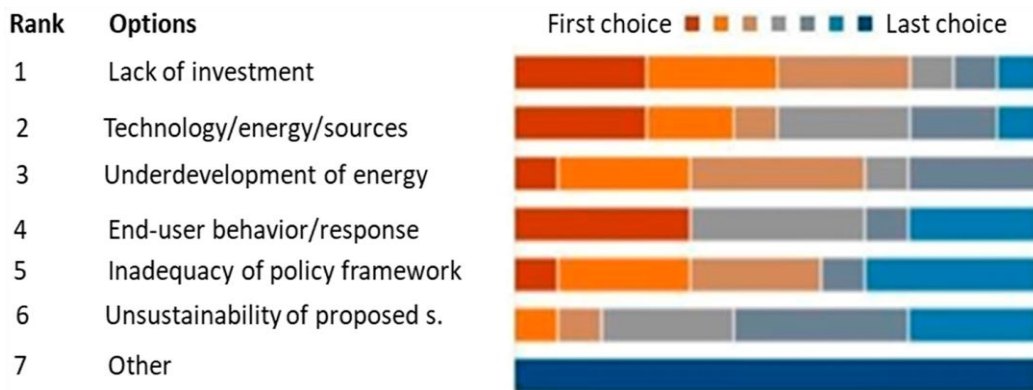
Infrastructure challenges, such as unreliable electricity or fuel supplies, can further hinder the adoption of clean cookstoves in certain areas. Widowed women may be reluctant to invest in clean cookstoves if they are uncertain about the availability of fuel or the dependability of electricity. Additionally, clean cookstoves require regular maintenance and occasional repairs to function effectively (Bartholomew, 2019; Md et al., 2022; Pariyar et al., 2022). Concerns about the cost and accessibility of maintenance services may deter widowed women from adopting these stoves.

Transitioning to clean cookstoves also necessitates a change in behavior, which can be difficult for widowed women accustomed to traditional cooking methods. Interventions aimed at encouraging behavioral change may be necessary to support widowed women in making this transition successfully. To address these challenges and limitations, a comprehensive approach is needed that takes into account the unique needs and circumstances of widowed women in Nigeria. By tackling these issues, stakeholders can help ensure that clean cookstove adoption becomes an effective strategy for enhancing the mental well-being of widowed women in the country.

9.1 Barriers to clean cookstove adoption among widowed women

Several barriers hinder the adoption of clean cookstoves among widowed women in Nigeria, impeding their potential benefits for health, well-being, and sustainability. These barriers are complex and multifaceted, reflecting a range of social, economic, and cultural factors: One of the primary barriers to clean cookstove adoption is the cost (Gould & Urpelainen, 2018, Quinn, et. al., 2018). Clean cookstoves, particularly those using modern technologies such as Liquefied Petroleum Gas (LPG) or electric stoves, can be more expensive upfront compared to traditional stoves. Widowed women, who may already be facing financial challenges, may find it difficult to afford these cleaner alternatives. In many parts of Nigeria, access to clean fuels such as LPG or ethanol is limited (Onah, Nyong & Ayuba, 2021, Onuvae, 2021, Onyeneke, et. al., 2023). This can be due to inadequate infrastructure for fuel distribution, as well as affordability issues. Widowed women may rely on traditional fuels like firewood or charcoal because they are more readily available and affordable, despite their negative health and environmental impacts. Lack of awareness and education about the benefits of clean cookstoves is another barrier. Many widowed women may not be aware of the health risks associated with traditional cooking methods or the availability of cleaner alternatives. They may also lack the knowledge or skills to effectively use and maintain clean cookstoves. Cooking practices are often deeply rooted in cultural norms and traditions. Some widowed women may be reluctant to switch to clean cookstoves due to a preference for traditional cooking methods or a perception that clean cookstoves are not compatible with their cultural practices. In some areas, infrastructure challenges such as lack of access to electricity or unreliable fuel supply can hinder the adoption of clean cookstoves. Widowed women may be reluctant to invest in clean cookstoves if they are unsure about the availability of fuel or the reliability of the electricity supply.

Figure 7a. Main barriers impeding a shift towards cleaner energy access for cooking in rural communities (Vassiliades, et. al., 2022).



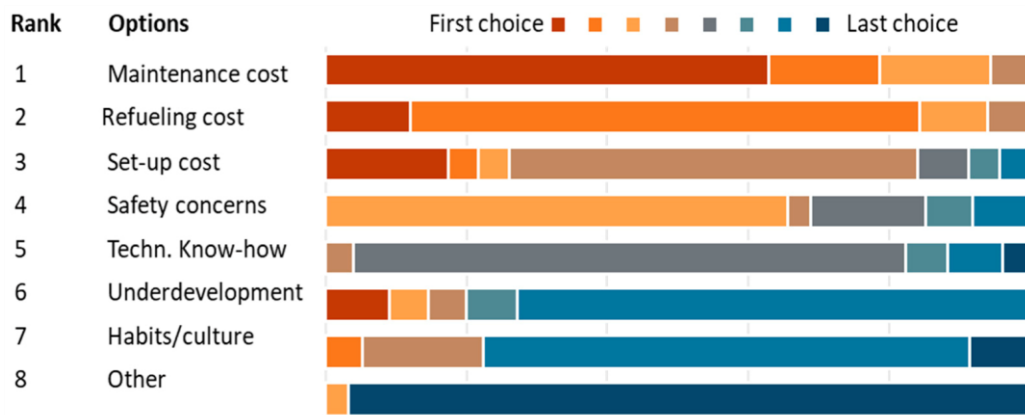
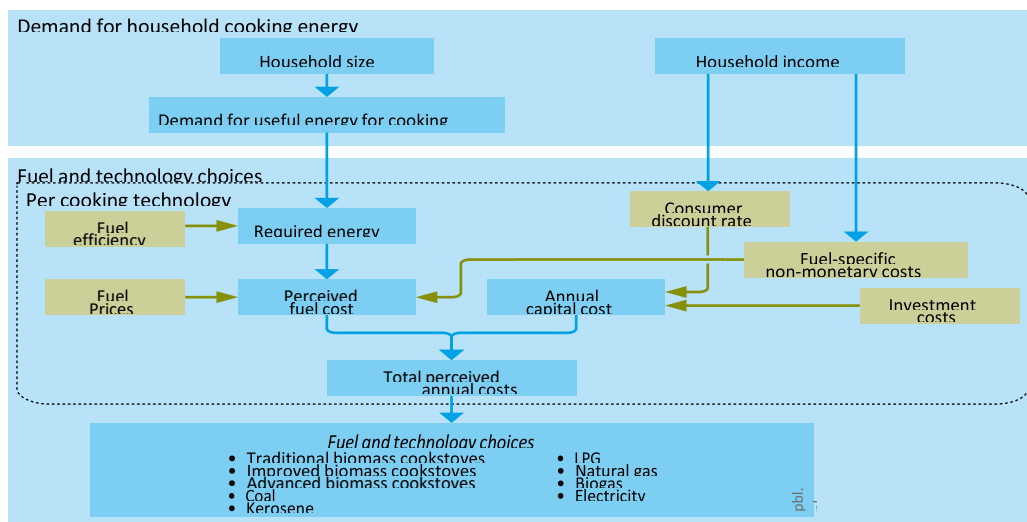


Figure 7b. Main barriers for shifting towards cleaner energy access for cooking (Vassiliades, et. al., 2022).

9.2 Socio-cultural factors influencing adoption rates

Socio-cultural factors play a significant role in influencing the adoption rates of clean cookstoves among widowed women in Nigeria (Date-Bah, 2022, Dongzagla & Adams, 2022, Otieno, 2019). These factors are deeply embedded in the cultural fabric of Nigerian society and can impact how widowed women perceive and adopt new technologies such as clean cookstoves. Understanding these factors is crucial for designing effective strategies to promote clean cookstove adoption and enhance mental well-being among widowed women.

Cooking practices in Nigeria are often deeply rooted in tradition and cultural norms. Many widowed women may be reluctant to switch to clean cookstoves due to a preference for traditional cooking methods (Dianne, 2018, Kebede, Tolossa & Tefera, 2022, Sana, et. al., 2020). These methods are often seen as a reflection of cultural identity and may be passed down through generations, making it challenging to introduce new technologies. The perception of clean cookstoves among widowed women can also influence adoption rates. Some may view clean cookstoves as unfamiliar or incompatible with their cooking practices, leading to resistance to change. Perception of clean cookstoves as "modern" or "urban" technologies may also contribute to hesitancy among widowed women living in rural areas. The size of a home, their income, energy demand are the main drivers of the type of energy used by homes as shown in figure 8.



Source: PBL

Figure 8: Drivers of the choice of household cooking technology (Dagnachew, et. al., 2019)

Gender roles and responsibilities can impact the adoption of clean cookstoves among widowed women (Dutta & Sahu, 2024, Nwaka, Uma & Ike, 2020). In many Nigerian households, women are primarily responsible for cooking, and their decision-making power regarding household technologies may be limited. Widowed women may face additional challenges in adopting clean cookstoves if they are not actively involved in decision-making processes. Social norms and peer influence can also affect the adoption of clean cookstoves. Widowed women may be influenced by the attitudes and behaviors of their peers and community members. Positive experiences and endorsements from trusted individuals can encourage widowed women to consider adopting clean cookstoves.

Access to information and education about the benefits of clean cookstoves is crucial for adoption. Widowed women who are aware of the health, environmental, and economic benefits of clean cookstoves are more likely to adopt them (Kebede, Tolossa & Tefera, 2022, Mamuya, Moshia & Mussa, 2018, Odo, et. al., 2021). Lack of access to information and education can hinder adoption rates. Economic factors, such as the cost of clean cookstoves and access to affordable fuels, can also influence adoption rates. Widowed women who face financial constraints may be unable to afford clean cookstoves or the fuels needed to operate them, limiting their adoption. Addressing these socio-cultural factors requires a multi-faceted approach that involves raising awareness, providing education, addressing gender norms, and ensuring affordability and accessibility of clean cookstoves. By understanding and addressing these factors, stakeholders can promote

clean cookstove adoption among widowed women in Nigeria, leading to improved mental well-being and overall quality of life.

9.3 Sustainability of clean cookstove initiatives in the long term

For clean cookstove initiatives to achieve long-term success in improving the mental well-being of widowed women in Nigeria, sustainability must be a central focus (Nchor, 2023; Ojobo, Oluwagbemiga & Shamang, 2024; Sani & Scholz, 2022). Sustainability encompasses financial, social, environmental, and institutional dimensions, all of which are essential to maintaining the viability and effectiveness of these initiatives over time. A major challenge to sustainability is ensuring financial stability. Programs must establish sustainable funding mechanisms to keep clean cookstoves affordable and accessible for widowed women in the long run. This could involve innovative financing approaches, such as microfinance options or collaborations between public and private sectors, to lower the initial costs of adopting clean cookstoves. Social sustainability is equally critical, requiring that clean cookstove initiatives align with the cultural and practical needs of widowed women and their communities. Engaging communities and adopting participatory methods—where widowed women are involved in designing, implementing, and monitoring programs—can enhance social acceptance. Additionally, empowering widowed women to champion clean cookstoves within their communities can further strengthen social sustainability.

Environmental sustainability is another key consideration. Initiatives must prioritize clean fuels and technologies that reduce greenhouse gas emissions and minimize ecological harm (Murshed, 2020; Rosenthal et al., 2018; Shankar et al., 2020). This includes promoting renewable energy sources like biogas or solar-powered cookers, as well as implementing strategies to curb deforestation and air pollution. Institutional sustainability ensures that clean cookstove initiatives are backed by robust policy frameworks and institutional support. This involves defining clear roles for stakeholders, building local capacity for monitoring and evaluation, and integrating clean cookstove programs into broader development plans.

Monitoring and evaluation are indispensable for assessing the impact and effectiveness of these initiatives and identifying areas for improvement (Jagger & Das, 2018; Quinn et al., 2018). Regular assessments help ensure that programs stay aligned with their goals and continue to meet the needs of widowed women and their communities. In summary, achieving the sustainability of clean cookstove initiatives demands a comprehensive approach that addresses financial, social, environmental, and institutional factors. By prioritizing these elements, stakeholders can ensure that clean cookstove adoption

remains a viable and impactful pathway to enhancing the mental well-being of widowed women in Nigeria for years to come.

10 Conclusion

In summary, the adoption of clean cookstoves offers significant promise as a means to improve the mental well-being of widowed women in Nigeria. By addressing key challenges such as indoor air pollution, saving time and effort, and providing psychological benefits through cleaner and more efficient cooking methods, clean cookstoves can profoundly enhance the lives of these women. This discussion has highlighted the multiple ways clean cookstoves can positively impact widowed women. Reducing indoor air pollution leads to better respiratory health and a safer home environment. The time and energy saved from using clean cookstoves also allow widowed women to engage in activities that boost their mental well-being, such as connecting with family or pursuing personal interests. Moreover, the widespread use of clean cookstoves can deliver broader societal and environmental advantages. By decreasing reliance on emissions, contributing to environmental sustainability. Empowering widowed women through clean cookstove adoption can also foster greater community involvement and economic independence, benefiting society at large. Given these insights, it is crucial for stakeholders—including policymakers, NGOs, and community leaders—to prioritize and support clean cookstove initiatives in Nigeria. Collaborative efforts, such as offering financial incentives, organizing training programs, and launching awareness campaigns, can make clean cookstoves more accessible and affordable for widowed women nationwide. In conclusion, clean cookstove adoption has the potential to significantly enhance the mental well-being of widowed women in Nigeria while addressing socio-economic and environmental issues. Stakeholders must recognize this potential and take decisive action to support clean cookstove initiatives, ultimately improving the lives of widowed women and advancing sustainable development in Nigeria.

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